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Herpetofauna in the city of Blagoevgrad, south-western Bulgaria

Alexander Pulev, Lidia Sakelarieva*

Department of Geography, Ecology and Environmental Protection, Faculty of Mathematics and Natural Sciences, South-West University "Neofit Rilski", 66 Ivan Mihailov Street, 2700, Blagoevgrad, Bulgaria

Abstract

The city of Blagoevgrad and its surroundings (about 16.4 km^2) were researched in order to establish the diversity, distribution and level of synanthropy of the amphibian and reptile species. Data about the herpetofauna were obtained in the period 1988–2012. Totally 25 species were registered – 10 amphibians and 15 reptiles. The number of species, discovered around the city, was 23, and 6 of them were not found within the administrative boundaries of the city. The different urban zones are inhabited by 19 species. They represent 37% of the amphibians and 31% of the reptiles, found in Bulgaria, and 64% of the amphibians and 60% of the reptiles, distributed in the Blagoevgrad municipality, which is very high species richness. The herpetofauna has found quite favourable conditions in the territory of the city as a whole, and especially in the sparsely populated and built up areas and city periphery. The presence of great variety of urban habitats and the pattern of situation of the city residential districts are very important for the successful adaptation of herpetofauna for inhabiting in urban environment. The high species richness could be explained also by the fact, that comparatively great number of amphibians and reptiles are hemerodiaphoric species, which easily exist in landscapes, transformed by man. The results from the case study of the herpetofauna in Blagoevgrad show that the urban areas could provide good conditions for the wild animals and could be places of substantial biological diversity.

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*Corresponding Author: Lidia Sakelarieva, e-mail: sakelarieva.lidia@swu.bg

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Introduction

Although cities are artificial systems created by man and the urban environment differ substantially from the natural one, a number of wild species have successfully adapted for inhabiting in urban areas. Some of them occur predominantly or exclusively in cities and form populations independent from those in the natural habitats [1].

There are comparatively few publications on the diversity of urban herpetofauna in the world. Some data about the distribution of the amphibians and reptiles in two Romanian cities are found in the publications of Strugariu et al [2, 3]. The situation in Bulgaria is similar. Purposeful research on the biodiversity and distribution of amphibians and reptiles in the Bulgarian cities is scarce. Only some of the largest cities were studied in this respect to some extent. Milchev [4] was the first who researched the amphibians in the city of Sofia. Recently the amphibians and reptiles in the South Park in Sofia were studied by Emin [5]. Data about herpetofauna of the Botanical garden in the city of Varna were published by Delov et al. [6]. The most extensive research of amphibians and reptiles in urban environment were carried out for the

territory of the city of Plovdiv [7-13].

Some data about the species composition of the herpetofauna in the city of Blagoevgrad and its surroundings are found in the publications of Buresch and Zonkow [14-16]. They reported 1 amphibian and 9 reptile species for this area. Later (1988–2008), all of them were confirmed, and new species were registered – 9 amphibians and 5 reptiles [17-19].

The aim of this study is to establish the diversity, distribution and the level of synanthropy of the amphibians and reptiles in the city of Blagoevgrad and its close surroundings.

Material and methods

Data about the herpetofauna, were obtained during several field trips, in the period 1988–2012. The studied area is about 16.4 km^2, situated in the south-western part of Bulgaria. It comprises the administrative territory of the city of Blagoevgrad and its close vicinity (1 km wide around the city). The area characterizes with a transitional climate regime. The city of Blagoevgrad is the administrative centre of the third largest region in Bulgaria. It has population of 70 881 [20] inhabitants and an area of 9.26 km^2. For the aims of the present study, the city territory has been divided into 4 urban zones with various types of habitats (aquatic and terrestrial), and with different density of buildings and population. A similar division was chosen by Strugariu et al [2]. The city is visually presented on a Google Earth satellite photo from 2011 (Fig. 1).

The amphibian and reptile species were determined visually using the field guide of Arnold and Ovenden [21] and Stoyanov et al. [22]. In some cases the animals were captured and after that released at the same place. Each species has been given a scientific name after Speybroeck et al. [23].

The Klausnitzer's [24] classification of species based on the level of synanthropy was used. According to it the animals are categorized into four ecological groups: hemerophobes (species, which avoid urban environment); hemerodiaphores (species, which existence doesn't depend on the anthropogenic transformation of the landscape), hemerophiles (species, which prefer habitats made by humans) and synanthropes (species, which are directly connected with habitats made by man and their existence depend on the human activity).

The similarity in species composition has been determined by using the Sörensen's index of similarity (QS %) [25].

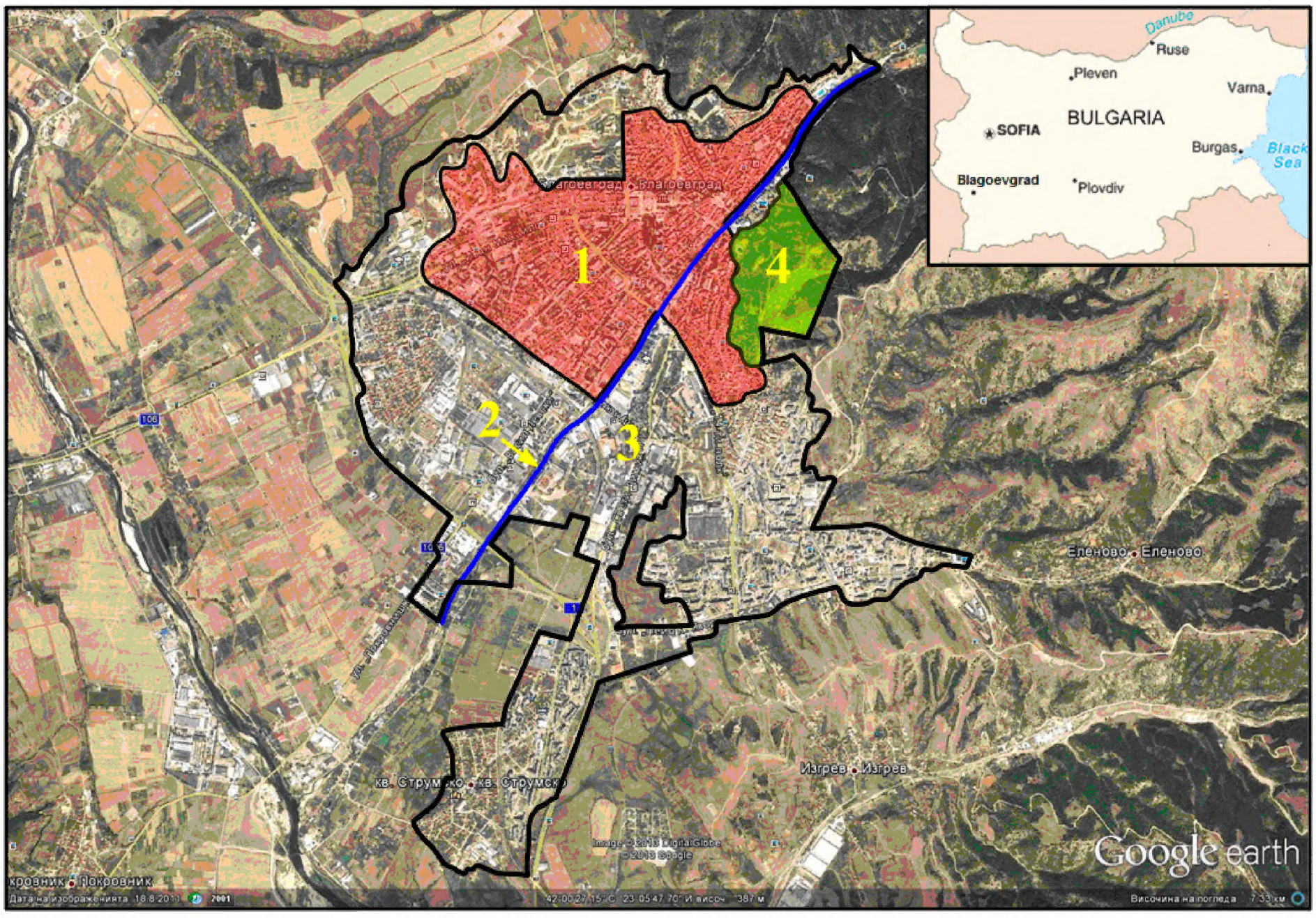

Figure 1. The city of Blagoevgrad and its surroundings. Urban zones: 1 – Densely populated and built up areas; 2 – The Blagoevgradska Bistritsa River and its banks; 3 – Sparsely populated and built up areas and city periphery; 4 – The Loven dom Park and the Zoo.

Results

During the recent surveys (2011–2012) one more reptile species, the Kotschy`s gecko (*Mediodactylus kotschyi*), which has not been registered in our previous studies, was discovered. Thus, the total number of the amphibian and reptile species, found in the city of Blagoevgrad and its close surroundings, is 25 – 10 amphibians (Table 1) and 15 reptiles (Table 2). They represent 53% of the amphibians and 38% of the reptiles, found in Bulgaria, and 91% of the amphibian and 75% of the reptile species, distributed in the territory of the Blagoevgrad municipality.

The number of species, distributed in the urban vicinity, was 23, and 19 species were established in the different urban zones (Fig. 1; Tables 1 and 2). Two species inhabit the densely populated and built up areas, 6 species were found in the Blagoevgradska Bistritsa River and or in the riparian habitats, 14 species – in the sparsely populated and built up areas and city periphery, and 10 species - in the Loven dom Park and the Zoo (Fig. 2). All of the amphibian species – 3 caudal and 7 anurans, inhabit the city surroundings and 7 of them – 2 caudal and 5 anurans, are distributed in the city, mainly in the sparsely populated and built up areas and city periphery (Table 1).

The reptile species are presented by 2 Testudinidae, one Emydidae, 6 Sauria species – one Gekkonidae, 4 Lacertidae, and one Anguidae, and 6 Serpentes. 13 species have been registered in the city surroundings and 12 species have been found in the urban zones, 8 of which in the sparsely populated and built up areas and city periphery (Table 2). Only 6 of the 23 species, distributed in the city surroundings, have not been found within the administrative boundaries of the city – *Lissotriton vulgaris, Bombina variegata, Rana graeca, Testudo graeca, Podarcis tauricus* and *Anguis fragilis.* At the same time, 2 species – *Mediodactylus kotschyi* and *Podarcis muralis,* inhabit some of the urban zones, and have not been found in the urban vicinity.

Six of all species, registered in the studied area, are aquatic – *Bombina variegata, Rana graeca, Pelophylax ridibundus, Emys orbicularis, Natrix natrix* and *Natrix tessellata.* The other 19 species are terrestrial but 7 of them (*Salamandra salamandra, Lissotriton vulgaris, Triturus karelinii, Bufo bufo, B. viridis, Hyla arborea* and *Rana dalmatina*) are distributed in moist habitats near the river and the irrigation canals. According to their level of synanthropy, the amphibian and reptile species, distributed in the city of Blagoevgrad, are categorized as follows: hemerophobes – 4 species (one amphibian and three reptiles); hemerodiaphores – 12 species (five amphibians and seven reptiles); hemerophiles – 2 species (one amphibian and one reptile); synanthropes – 1 reptile species (Table 3).

Table 1. Distribution of amphibians in the city of Blagoevgrad and its surroundings.

№	Species	Urban zones				Rural
		Densely populated and built up areas	The Blagoevgradska Bistritsa River and its banks	Sparsely populated and built up areas and city periphery	The Loven dom Park and the Zoo	City surroundings
1.	*Salamandra salamandra* (Linnaeus, 1758)	–	–	+	–	+
2.	*Lissotriton vulgaris* (Linnaeus, 1758)	–	–	–	–	+
3.	*Triturus karelinii* (Strauch, 1870)	–	–	+	–	+
4.	*Bombina variegata* (Linnaeus, 1758)	–	–	–	–	+
5.	*Bufo bufo* (Linnaeus, 1758)	–	–	+	+	+
6.	*B. viridis* (Laurenti, 1768)	+	–	+	+	+
7.	*Hyla arborea* (Linnaeus, 1758)	–	–	+	–	+
8.	*Rana dalmatina* Fitzinger, 1839	–	+	–	+	+
9.	*R. graeca* Boulenger, 1891	–	–	–	–	+
10.	*Pelophylax ridibundus* (Pallas, 1771)	–	+	+	+	+

Table 2. Distribution of reptiles in the city of Blagoevgrad and its surroundings.

№	Species	Urban zones				Rural
		Densely populated and built up areas	The Blagoevgradska Bistritsa River and its banks	Sparsely populated and built up areas and city periphery	The Lovendom Park and the Zoo	City surroundings
1.	*Testudo hermanni* Gmelin, 1789	–	–	–	+	+
2.	*T. graeca* Linnaeus, 1758	–	–	–	–	+
3.	*Emys orbicularis* (Linnaeus, 1758)	–	–	+	+	+
4.	*Mediodactylus kotschyi* (Steindachner, 1870)	–	–	+	–	–
5.	*Lacerta viridis* (Laurenti, 1768)	–	+	+	+	+
6.	*Podarcis erhardii* (Bedriaga, 1882)	–	–	+	+	+
7.	*P. muralis* (Laurenti, 1768)	+	+	–	–	–
8.	*P. tauricus* (Pallas, 1814)	–	–	–	–	+
9.	*Anguis fragilis* Linnaeus, 1758	–	–	–	–	+
10.	*Natrix natrix* (Linnaeus, 1758)	–	+	+	–	+
11.	*N. tessellata* (Laurenti, 1768)	–	+	–	–	+
12.	*Dolichophis caspius* (Gmelin, 1789)	–	–	+	+	+
13.	*Platyceps najadum* (Eichwald, 1831)	–	–	+	–	+
14.	*Zamenis longissimus* (Laurenti, 1768)	–	–	–	+	+
15.	*Vipera ammodytes* (Linnaeus, 1758)	–	–	+	–	+

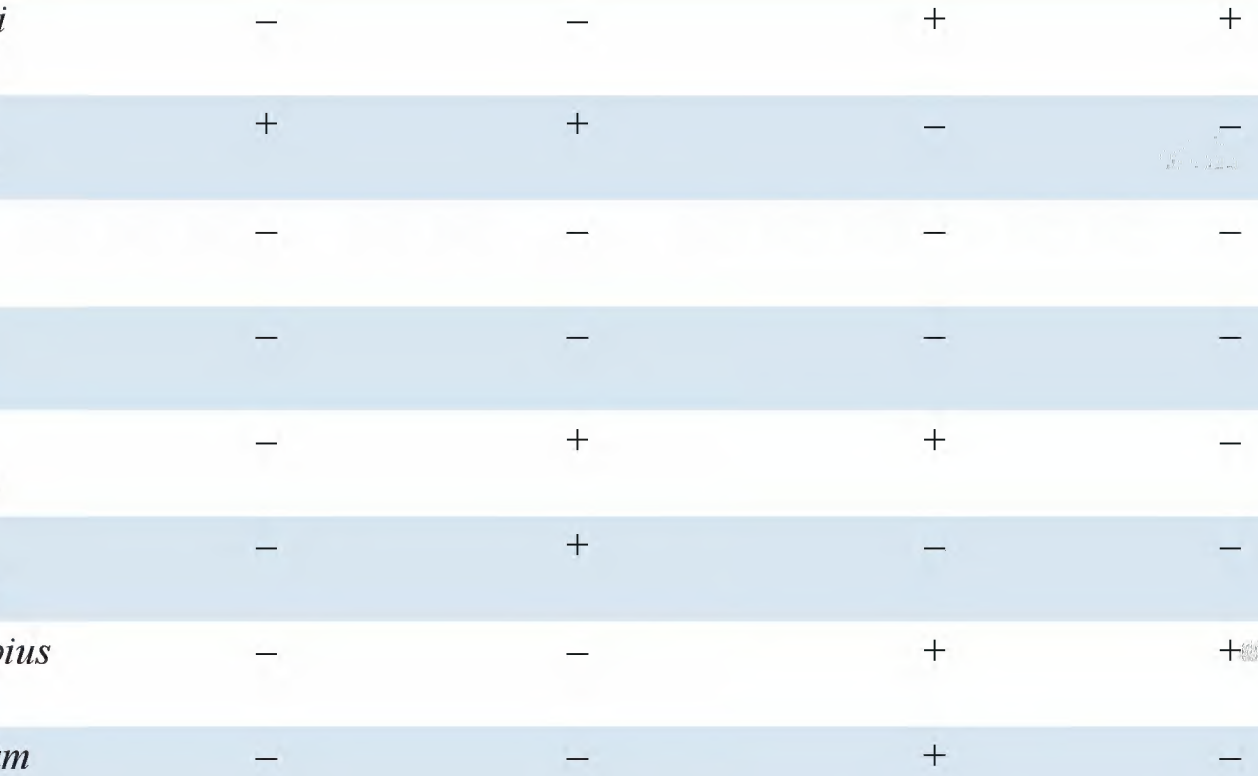

Figure 2. Number of species in the urban zones.

Table 3. Ecological groups of amphibians and reptiles, according to their level of synanthropy.

Level of synanthropy	Species
Hemerophobes	*Rana dalmatina, Podarcis erhardii, Platyceps najadum, Vipera ammodytes*
Hemerodiaphores	*Salamandra salamandra,Triturus karelinii, Bufo bufo, Hyla arborea, Pelophylax ridibundus, Testudo hermanni, Emys orbicularis, Lacerta viridis, Natrix natrix, N. tessellata, Dolichophis caspius, Zamenis longissimus*
Hemerophiles	*Bufo viridis, Podarcis muralis*
Synanthropes	*Mediodactylus kotschyi*

Discussion

The number of amphibian and reptile species, found in Blagoevgrad and its vicinity (25), is comparable with that, registered in the period 1905–2005 [11] in the city of Plovdiv and its surroundings (27). As the climate regimes are comparatively the same in both of the regions, the similarity in species composition of the herpetofauna is very high – 77%. For the amphibian species only, the value of the index of similarity is even higher – 80%, and for the reptiles, it is 75%. However, the studied areas quite differ in size. The studied area in the research of the city of Plovdiv and its surroundings – 127 km^2 [9], is more than 7 times larger than that of Blagoevgrad and its vicinity (16.4 km^2), and only the territory of Plovdiv (53 km^2) is almost six times larger than that of Blagoevgrad (9.26 km^2). This means, that the species diversity of the herpetofauna on a square km in the city of Blagoevgrad and its surroundings is very high, and it is much higher than that, in the city of Plovdiv and its vicinity.

The value of the Sörensen index for the amphibians, registered in the cities of Sofia [4] and Blagoevgrad, is also very high – 86%. The distance between the two cities is about a 100 km and the amphibian species, registered there, are pretty common for the country, which explains this high similarity. The amphibian and reptile species, recorded only within the administrative territory of Blagoevgrad, represent 37% of the amphibians and 31% of the reptiles, found in Bulgaria, and 64% of the amphibians and 60% of the reptiles, distributed in the Blagoevgrad municipality, which is very high species richness. Obviously, the herpetofauna has found quite favourable conditions in the city as a whole and especially in the sparsely populated and built up areas and city periphery. The presence of great variety of habitats – courtyards, small parks and gardens, spaces between the buildings, large parks, a river that flows through the city, abandoned lands, different types of residential buildings etc., as well as the pattern of situation of the city residential districts, are very important for the successful adaptation of the herpetofauna for inhabiting in urban environment. Similar results were obtained by Mollov [9] for the city of Plovdiv.

The high species richness could be explained also by the fact, that comparatively great number of amphibians and reptiles are hemerodiaphoric species, which easily exist in landscapes, transformed by man, if there are suitable habitats. Individuals of the four hemerophobic species were established only in the city periphery and in the Loven dom Park (Fig. 1), and probably they are members of populations that inhabit mainly the city surroundings. All hemerodiaphores are distributed around the city and, as their existence doesn't depend on the anthropogenic transformation of the landscape, they have found suitable conditions for inhabiting in the city.

One of the hemerophilic species, *Bufo viridis*, is widely distributed in the studied area, and is the only amphibian species, found in the densely populated and built up areas. The other hemerophilic species, the common wall lizard (*P. muralis*), forms a population, independent from the species populations in the natural habitats. It has been found only in the central parts of the city. Strugariu et al [3], who studied the distribution of *P. muralis* in Bucharest, have also registered its presence in the center of the city. Arnold and Ovenden [21] wrote that "more than any other small lacerta, it occurs near human habitations". It is interesting to point out its competitive relationships with one of the other two wall lizards - the Erhard`s wall lizard (*P. erhardii*), which is found in the city periphery and city surroundings. It is a little larger and stronger than the common wall lizard, but Arnold and Ovenden [21] consider that in north of its range, *P. erhardii* is replaced by *P. muralis* near human habitation. And this is the case in the densely populated and built up areas in Blagoevgrad. Mollov [8], who studied the herpetofauna of the city of Plovdiv, classified *P. muralis* as a hemerophobic species. However, the common wall lizard is a typical hemerophile in Blagoevgrad. If there wasn't the city, where it finds suitable conditions, similar to the natural habitats it prefers, there wouldn't be a population of this species in this area. *P. muralis* is an example of a species, whose level of synanthropy may differ from city to city.

The only synanthropic species – *Mediodactylus kotschyi,* has been found, for now, only in the city

periphery. This small member of the family Gekkonidae prefers inhabiting in warm climate. The city of Blagoevgrad is the northern frontier of its range in the Struma River valley, where all of its known localities, in the territory of Bulgaria, are anthropogenic (inhabitable buildings in the settlements). The presence of the Kotschy`s gecko in Blagoevgrad could be explained by the accidental carrying by people from the settlements, situated to the south. Its nearest known locality is in the village of Cherniche, at about 20 km south of Blagoevgrad. At least one population is distributed in the city (different individuals in different years – 2011 and 2012, were registered). It is quite possible new populations to be found, as the conditions for its existence in the city are pretty good. However the distribution of the Kotschy`s gecko in Blagoevgrad is limited in contrast to other large cities in south-western Bulgaria, such as Petrich, Sandanski and Gotse Delchev, where this species is common.

The results from the case study of herpetofauna in the city of Blagoevgrad show, that the urban areas could provide good conditions for the amphibians and reptiles, and could be places of substantial biological diversity. The future investigations will aim at determining some of the population characteristics of the amphibian and reptile species, and the space they occupy.

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